



**Global Ocean Monitoring and Observing**  
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

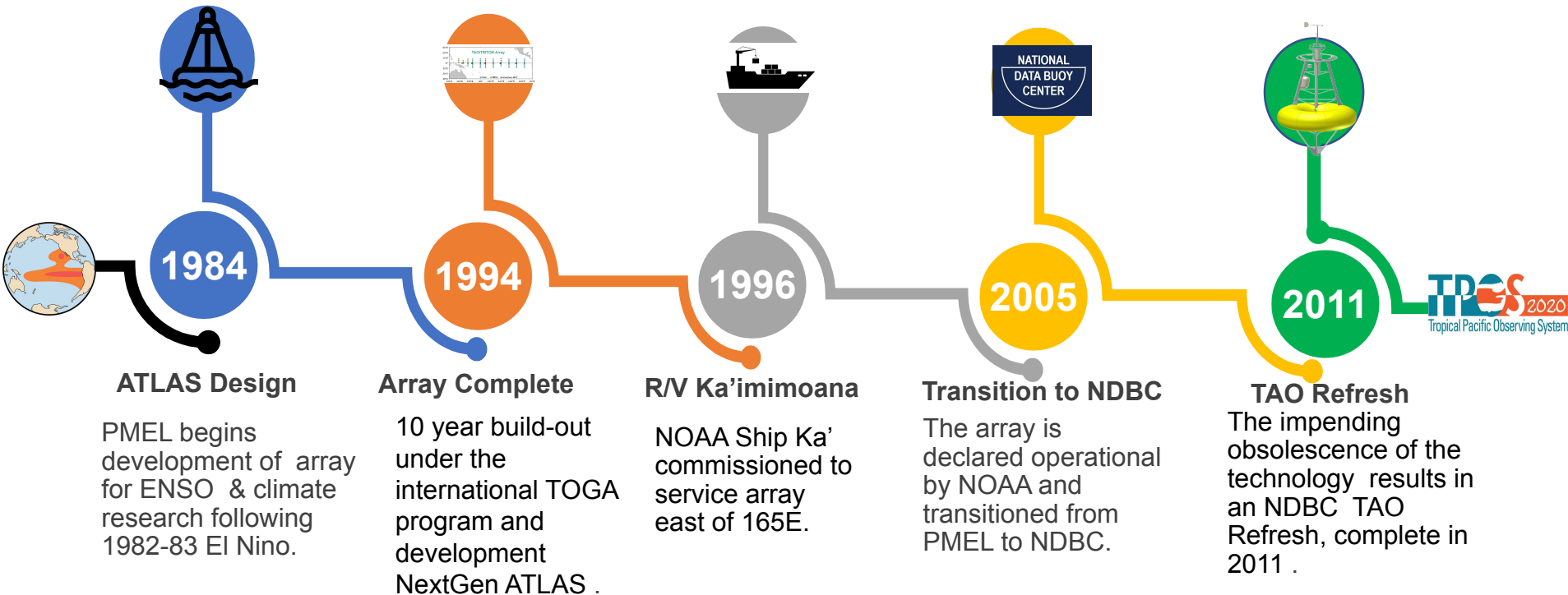
# **Sustaining a Moored Ocean Observing System: The Future of the TAO Array within the Tropical Pacific Observing System**

Global Ocean Monitoring and Observing Program Review  
13 July, 2022

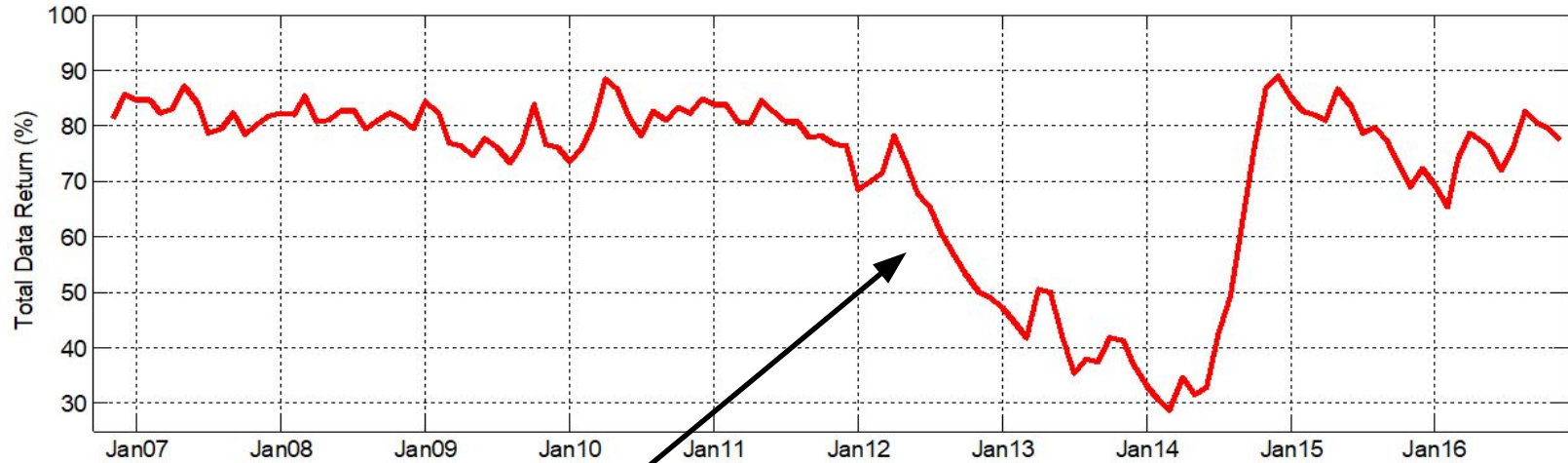
Karen Grissom

NOAA/NWS/National Data Buoy Center, Stennis Space Center, MS 39529 USA

# TAO Program History



# The Turning Point



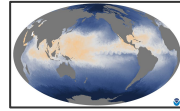
Last Ka' cruise



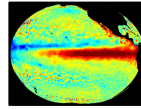
Data availability is coupled to the number of days at sea servicing buoys.

# The Tropical Pacific Observing System

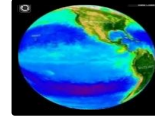
Satellite  
Observations:



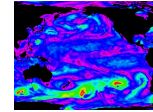
**SST**



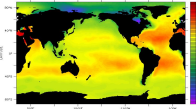
**SSH**



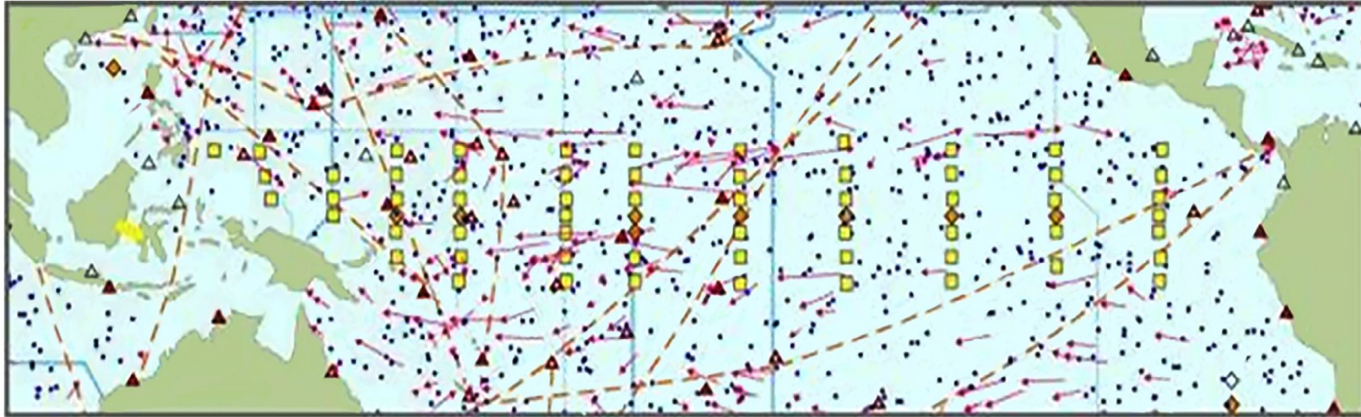
**Ocean Color**



**Wind**



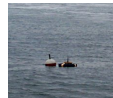
**Salinity**



In situ  
Observations:



**VOS**



**Drifters**



**Tide  
Gauges**



**XBT**



**Buoys**



**ARGO**



**Go-  
SHIP**



**Emerging  
Tech.**

**The intersection of Science, Technology, Research and Operations**

# TPOS 2020: GOMO Role

- Supported/advocated the integrated vision of TPOS 2020 Project
- Advanced TPOS as a agency priority
- Facilitate cross NOAA Line Office Collaboration, OAR:NWS & PMEL:NDBC
- Lead/coordinate the NOAA TPOS Working Group (TWG)
- Lead coordination of NOAA Implementation Plan Team (aka Tiger Team)
- Sponsored a series of pilot projects on in-situ technology to contribute to TPOS 2020

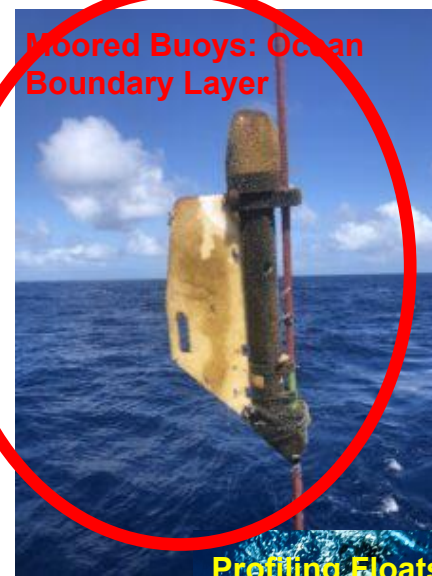




**Autonomous Surface Vessels:  
Saildrone**



**Moored Buoys: Direct  
Covariance Flux System**



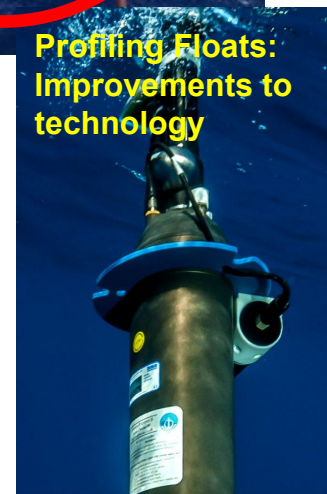
**Moored Buoys: Ocean  
Boundary Layer**



**Profiling Floats: Rain, Wind, & BCG**



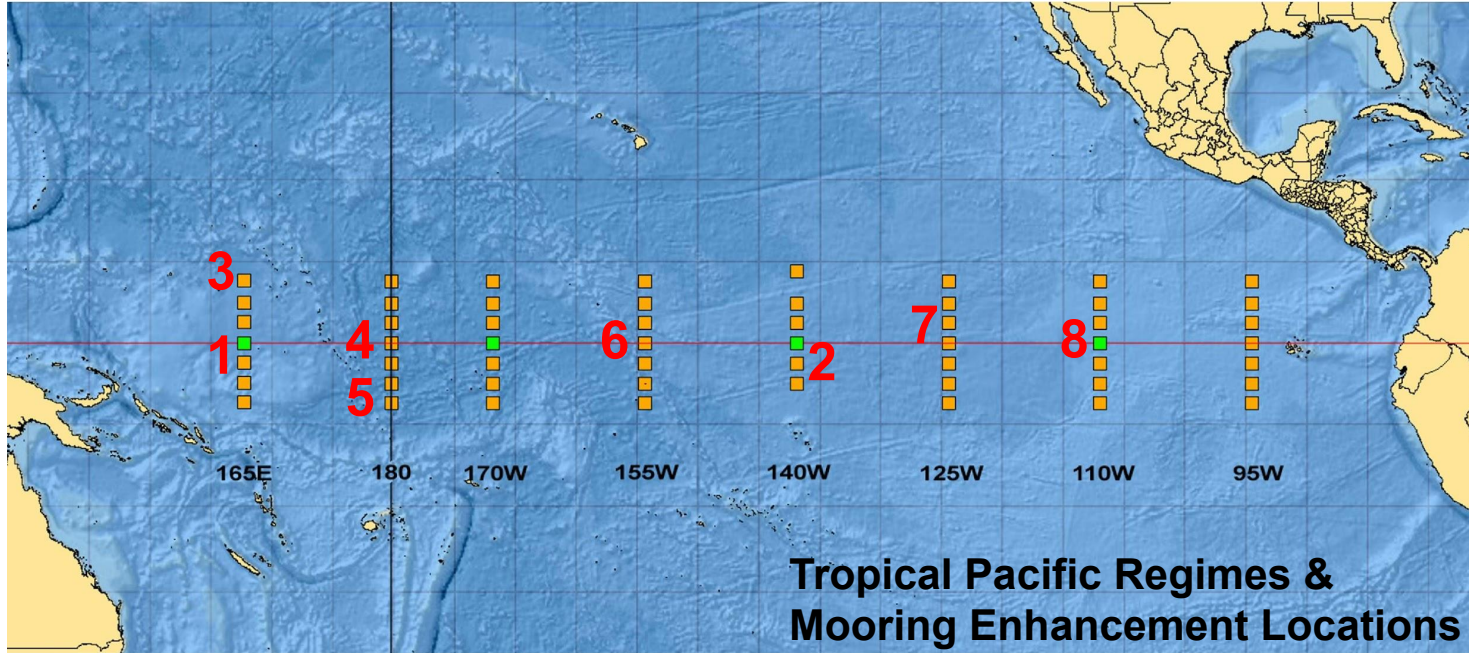
**Profiling Floats: BCG,  
bio-productivity, CO2  
fluxes, & hypoxia**



**Profiling Floats:  
Improvements to  
technology**

# **TPOS Pilot Projects**

# “Enhanced Ocean Boundary Layer Observations on NDBC TAO Moorings”

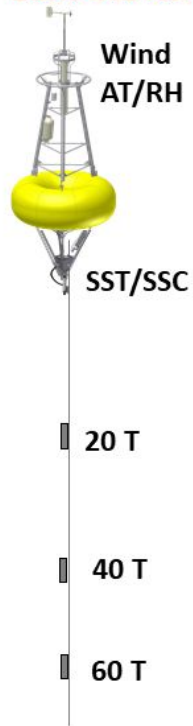


Existing Historical Stations      FLUX Stations

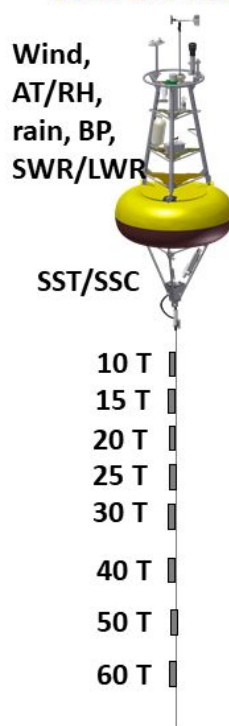
- |                                 |                               |                              |
|---------------------------------|-------------------------------|------------------------------|
| 1. West Pac warm pool (2S 165E) | 2. Ekman divergence (2S 140W) | 3. ITCZ (8N 165E)            |
| 4. Edge of warm pool (0 180)    | 5. SPCZ (8S 180)              | 6. Strong Eq trades (0 155W) |
| 7. Cold tongue front (2N 125W)  | 8. Core cold tongue (0 110W)  |                              |

# New Technology and Observations: The Redesign of an Array

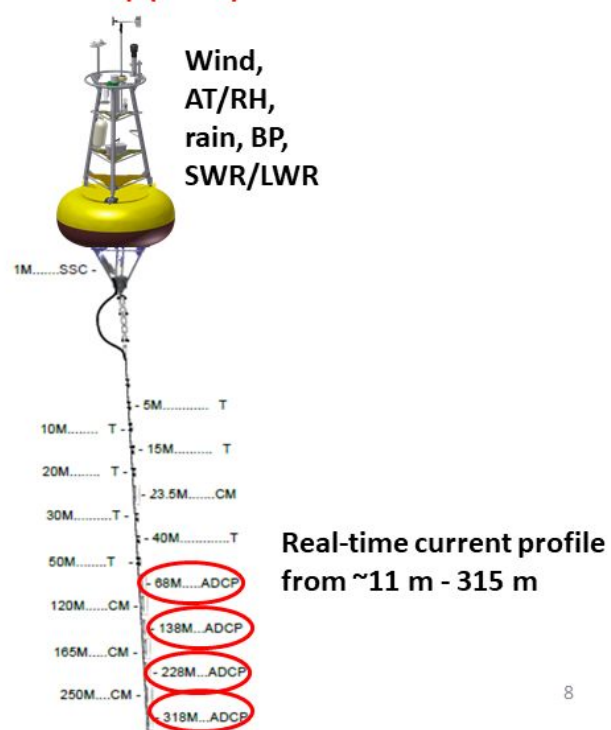
Basic TAO Refresh



Basic TAO Recap (Tier 1)



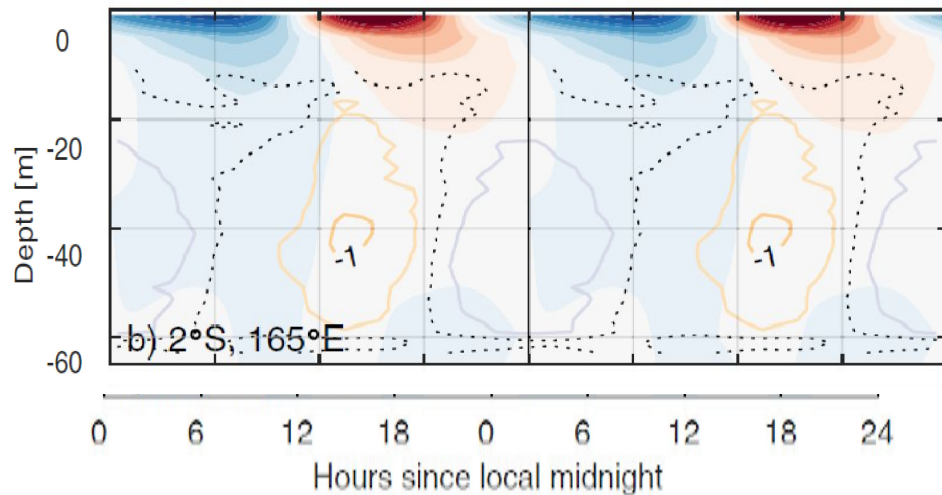
TAO Recap (ADCP)



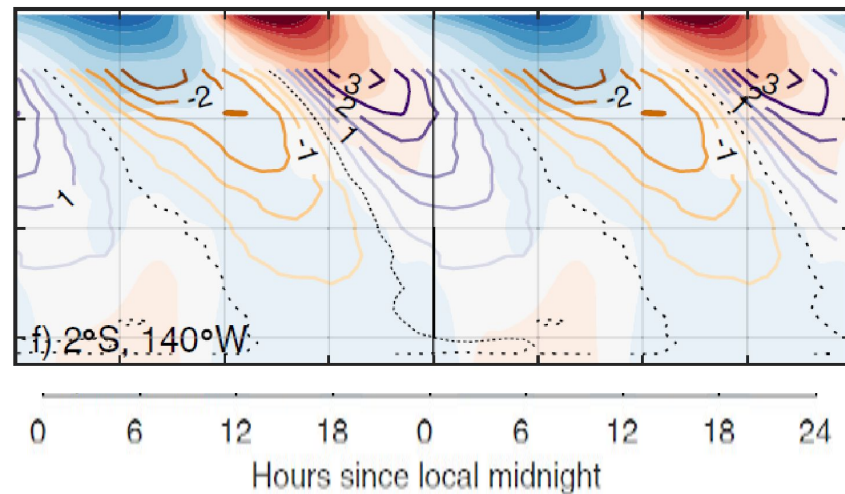


# TAO/TPOS Enhancements: Diurnal cycles

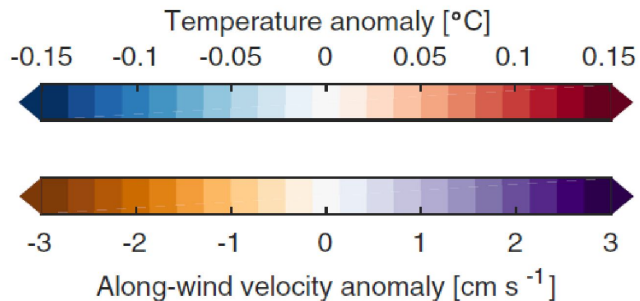
West Pacific Station



East Pacific Station



Masich et al., 2021



# TPOS Enhanced DCFS Mooring



## Deployment

- Date: October 4, 2019
- Location:  $0^\circ$ ,  $165^\circ\text{E}$

## Instrumentation

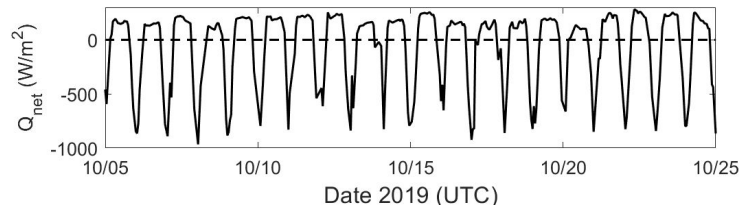
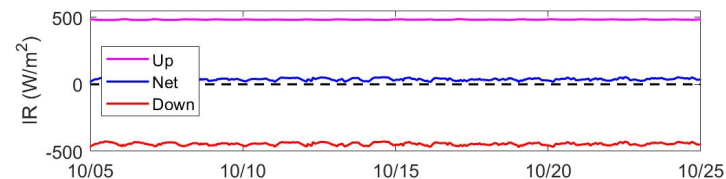
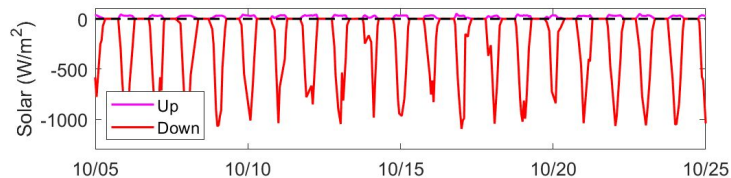
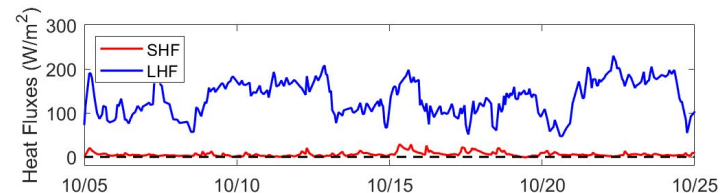
- 3-axis Sonic Anemometer
- 3-axis Motion Package
- Solar and IR Radiometers
- Redundant RH/ $T_{\text{air}}$  Sensors
- Barometer
- Rain Gauge
- $T_{\text{sea}}$  and Salinity Sensors
- ADCP/ADV Daisy-chain

## Real-time Delivery of

- Direct Covariance Surface Stress and Buoyancy Fluxes
- Radiative Fluxes
- Bulk Sensible and Latent Heat Fluxes
- Net Heat Flux
- Near Surface Currents
- Ocean Current Profiles



## Heat Budget Terms





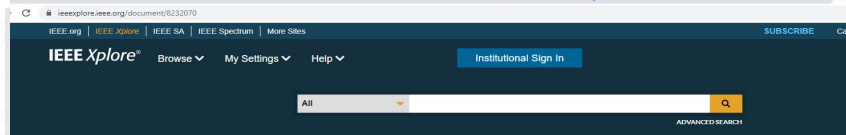
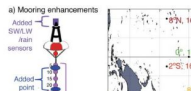
# Pilot Project Publications

## Enhanced Ocean Boundary Layer Observations on NDBC TAO Moorings

Pls: Karen Grissom (NOAA/NWS/NDBC), William Kessler (NOAA/PMEL), Meghan Cronin (NOAA/PMEL), and Jessica Masich (NRC, NOAA/PMEL)

### Description

NOAA's Pacific Marine Environmental Laboratory and National Data Buoy Center installed Acoustic Doppler Current Profilers on Tropical Atmospheric Ocean moorings at nine sites across the tropical Pacific. These sensors measured velocity in the near-surface ocean between seven meters and 65 meters depth, typically a 'blind spot' in the water column for observations of ocean currents.



Conferences > OCEANS 2017 - Anchorage

### Adding a real-time current profile to NDBC TAO moorings for enhanced ocean boundary layer observations

Publisher: IEEE [Cite This](#) [PDF](#)

Karen Grissom; James E. Elliott; Travis Singelton; William Thompson; Jennifer Keene **All Authors**

35  
Full  
Text Views

#### Abstract

#### Document Sections

- I. Introduction
- II. System Design
- III. Operational Field Test
- IV. Results & Discussion
- V. Conclusions

#### Abstract:

A known characteristic of the Tropical Pacific is the interaction between the zonal winds and the equatorial thermocline, which allows coupled variability like ENSO to evolve. However, this fundamental feedback is the least understood and most poorly modeled element of the tropical climate system. To increase our knowledge of the mechanisms controlling this feedback process, NOAA's National Data Buoy Center (NDBC) and Pacific Marine Environmental Laboratory (PMEL) have collaborated on a joint project to enhance operational NDBC Tropical Atmosphere Ocean (TAO) moorings. The four-year project is part of a larger internationally coordinated effort, TPOS 2020, to refine components of the Tropical Pacific Observing System. The goal of this project is to develop the methodologies to better resolve near surface stratification in real-time to support operational climate forecasting and ENSO research. To this end, eight TAO moorings, in regimes that span the phenomena of the mixed layer processes in the tropical Pacific, will be upgraded with new capabilities and added value. Some of these new capabilities include a real-time current profile for the upper 70 meters, and enhanced vertical resolution of the temperature-salinity

Full Article: [PDF](#)

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IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing  
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## JGR Oceans

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### Diurnal Cycles of Near-Surface Currents Across the Tropical Pacific

Jessica Masich [Email](#) William S. Kessler, Meghan F. Cronin, Karen R. Grissom

First published: 02 April 2021 | <https://doi.org/10.1029/2020JC016982> | Citations: 1

SECTIONS

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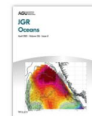
### Abstract

Solar radiative heat and wind-forced momentum can be trapped at the surface and transmitted into the ocean interior via a daily descending shear layer that mixes heat and momentum downwards. Here, we characterize the extent of this mechanism across the tropical Pacific via seven mooring deployments spanning the eastern and western tropical Pacific and the Inter-Tropical and South Pacific Convergence Zones. We find a

uring SPURS with the inclusion of an infrared hygrometer to make fast-response isurement of latent and sensible heat fluxes from the buoyancy flux. This was ep well and additional batteries. Efforts are currently underway to reduce the power ower platforms.

ing are finding their way onto operational buoy arrays. This abstract describes a

[view issue TOC](#)  
Volume 32, No. 2  
Pages 122 - 133



Volume 126, Issue 4  
April 2021  
e2020JC016982

Figures References Related Information

### Recommended

[Near-surface variability of temperature and salinity in the near-tropical ocean: Observations from profiling floats](#)

Jessica E. Anderson; Stephen C. Riser  
Journal of Geophysical Research: Oceans

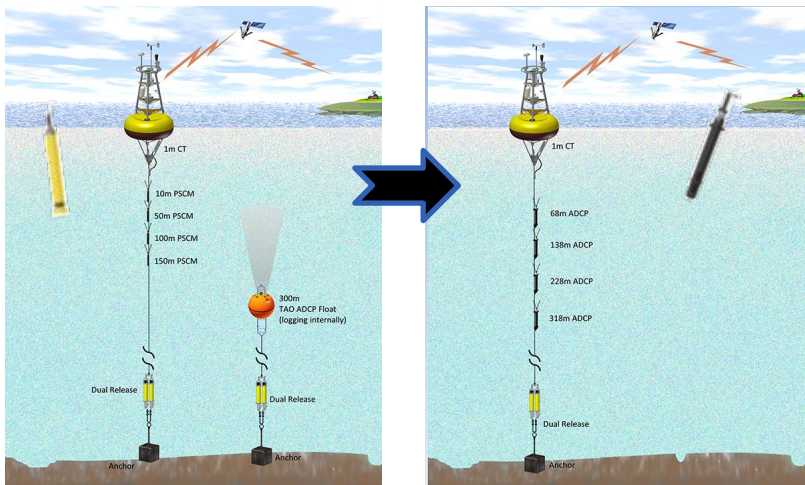
[Near-surface variability of temperature](#)





# Transition Research to Operations

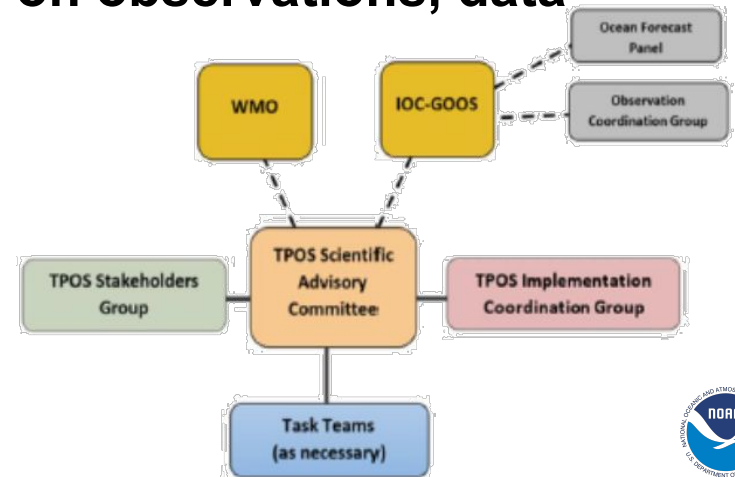
- GOMO facilitate the transition of technology to operational status
- Revitalize observing system backbone based upon a series of GOMO-funded TPOS pilot projects and TPOS
- Garnered support for TPOS science recommendations as described in the TPOS 2020 Final Report





# TPOS: The Path Forward

- Recapitalize TAO to modernize & provide value-added new technologies - Reconfigured “backbone” array
- Observations to advance understanding of ENSO and tropical Pacific physical and biogeochemical variability.
- Work with national/international ocean observing programs to implement the TPOS recommendations on observations, data management, & models/DA
- Build community consensus on future of Tropical Pacific – new TPOS Governance



A photograph of a sunset over the ocean, viewed from the perspective of someone on a boat. The sun is low on the horizon, casting a warm orange glow across the sky and water. The sky is filled with scattered clouds, some of which are illuminated by the setting sun. The water is dark blue with small waves. In the foreground, the side of a boat is visible on the left, and the railing of the boat is at the bottom.

# Thank You

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